APPARATUS FOR CLAMPING A PRINTING MEDIA

Reference to Related Application

[0001] This application claims the benefit of the filing date of co-pending application No. 60/391,440 filed on 26 June 2002 and entitled METHOD AND APPARATUS FOR CLAMPING A PRINTING MEDIA, which is hereby incorporated herein by reference.

Technical Field

[0002] This invention relates to imaging of media and more particularly to apparatus for holding media sheets on imaging beds.

Background

[0003] In the printing pre-press industry, it is often necessary to retain a plate or sheet of media on a surface so that it can be imaged. Typically, an imaging source is scanned relative to the surface of the media by either moving the imaging source or the media or a combination thereof. For example, many computer-to-plate or computer-to-press systems image a lithographic printing plate that is held onto the outside surface of a rotating drum. Systems are also available for imaging a plate held on the internal surface of a cylinder or on a flat platen.

[0004] Commonly assigned US Patent 6,130,702 to Ganton shows a combination of a mechanical reference edge and clamp for retaining the leading edge of a plate and magnetic clamps for retaining the trailing edge of the plate. The leading edge clamp is usually fixed in location while the magnetic clamp can be placed in a variety of locations to suit a range of plate sizes. The drum is made of a ferromagnetic material such as cast iron or has ferromagnetic inserts.

[0005] There remains a need for better magnetic clamps for holding media to imaging beds. There is a particular need for such clamps that provide increased holding forces and can accommodate media of different thicknesses.

Summary of the Invention

[0006] This invention provides magnetic clamping systems for clamping media to imaging beds. The systems include magnetic assemblies which are moveable relative to a clamp frame and have a biasing mechanism which biases the clamp frame toward the imaging bed.

[0007] In a first aspect of this invention, a magnetic clamp for securing a media to an imaging bed comprises a clamp frame adapted to engage the media and at least

one magnet located in the clamp frame. The magnet is moveable between a first position wherein the magnet is spaced apart from said imaging bed and a second position wherein the magnet engages the imaging bed. The clamp has a spring for resiliently biasing the magnet toward the first position.

[0008] In another aspect of the invention, the magnetic clamp is provided with means for temporarily reducing the attractive force between the magnetic assembly and the imaging bed to facilitate a clamping or retracting operation.

[0009] Further aspects of the invention and features of specific embodiments of the invention are set out below.

Brief Description of the Drawings

[0010] In drawings which illustrate example embodiments of the invention:

FIG. 1-A is an isometric view of the top surface of a clamp according to an embodiment of the present invention;

FIG. 1-B is an isometric view of the bottom surface of the clamp depicted in FIG. 2-A;

FIG. 1-C shows a longitudinal sectional view of the clamp depicted in FIG. 1-A;

FIG. 2-A to FIG 2-C depict an end view a clamping operation of a preferred embodiment of the clamp;

FIG. 3 is an isometric view of a clamp with a retracting device shown in place on each magnet;

FIG. 4-A to FIG. 4-D depict a series of steps performed in clamping a media on a ferromagnetic surface;

FIG. 5-A to FIG. 5-C depict a series of steps performed in un-clamping a media from a ferromagnetic surface;

FIG. 6 is a sectional view of a magnet assembly showing a shorting bar in place for retracting the magnet from a ferromagnetic surface;

FIG. 7 is an isometric view of an alternative embodiment of the clamp according to the present invention;

FIG. 8-A and 8-B are isometric views of another alternative embodiment of the clamp;

FIG. 9A and 9B are schematic cross sections through a clamp according to an alternative embodiment of the invention in with a magnet assembly in retracted and engaged positions respectively;

FIG. 10A and 10B are schematic cross sections through a clamp according to an alternative embodiment of the invention in with a magnet assembly in retracted and engaged positions respectively; and,

FIG. 11 illustrates a magnet assembly having pole pieces curved to match a curvature of a drum.

Description

[0011] Throughout the following description, specific details are set forth in order to provide a more thorough understanding of the invention. However, the invention may be practiced without these particulars. In other instances, well known elements have not been shown or described in detail to avoid unnecessarily obscuring the invention. Accordingly, the specification and drawings are to be regarded in an illustrative, rather than a restrictive, sense.

[0012] In an embodiment of the invention shown in FIG. 1-A, a clamp **20** comprises a pair of magnet assemblies **22** mounted on a frame **21**. Frame **21** is U-shaped in cross section. Frame **21** has an edge portion **21A** which can press against a media sheet **11** and therefore constitutes a media-engaging portion of frame **21**. Each magnet assembly **22** has a central permanent magnet **24** with pole pieces **26** located on either side of permanent magnet **24**.

[0013] A longitudinal section through clamp **20** is shown in FIG. 1-C. Clamp **20** is located on ferromagnetic surface **10** which may be part of an imaging bed. The imaging bed may comprise the surface of a drum or a flat surface, for example. The imaging bed may be made from a ferromagnetic material, such as cast iron, or may have ferromagnetic inserts in the appropriate areas. Pole pieces **26** are arranged to contact ferromagnetic surface **10**. Permanent magnet **24** is recessed relative to pole pieces **26** so that permanent magnet **24** is spaced apart from surface **10** of the imaging bed by a gap **30**. Advantageously permanent magnet **24** has pole pieces **26** permanently attached or bonded to it to form a magnet assembly **22** but this is not mandatory. The term "magnet assembly" or "magnet" is used herein to refer to an assembly including a permanent magnet disposed to provide a magnetic

clamping force according to the invention. A magnet assembly or magnet may include one or more pole pieces of ferromagnetic material.

[0014] Permanent magnets **24** are preferably rare earth compounds having high Energy Product for their size. Energy Product indicates the energy that a magnetic material can supply to an external magnetic circuit when operating at any point on its demagnetization curve. Energy products is measured in megagauss-oersteds (MGOe). While ceramic or ALNICO magnets may be used, they tend to have a poor energy product to weight ratio. The additional weight of such permanent magnets will at least partially defeat the additional holding forces gained at higher rotational speeds.

[0015] In the embodiment of Figs. 1-A and 1-B, magnets **22** are free to slide in slots **34** provided in frame **21** in the direction of arrow **32** to allow a range of different thickness media to be clamped while maintaining pole pieces **26** in contact with surface **10**. FIG. 1-B shows the underside of clamp **20**. Magnets **22** are retained by a number of flat springs **28**. Flat springs **28** provide a spring suspension for magnets **22** allowing them to slide in frame **21** under the retaining force of springs **28**, thus accommodating plates **11** having different thicknesses.

[0016] The function of springs **28** is explained with reference to FIGS. 2-A to 2-C. In FIG. 2-A, a clamp **20** is shown in a retracted position. Springs **28** urge magnet **22** away from surface **10** and toward clamp frame **21**. In FIG. 2-B, clamp **20** is placed on ferromagnetic surface **10** with edge **21A** of frame **21** holding an edge of media **11** to imaging bed **10**. In this position, an attractive force is established between magnet **22** and ferromagnetic surface **10**. In FIG. 2-B, magnets **22** are still in the retracted position. In the retracted position, pole pieces **26** are spaced apart from surface **10** by a distance ***D***, and the attractive force between magnets **22** and surface **10** is relatively weak. Springs **28** have stiffness sufficient to overcome this relatively weak attractive force. Thus, springs **28** hold magnets **22** retracted away from surface **10** while frame **21** of clamp **20** is brought into contact with surface **10** and arranged to hold media **11**.

[0017] In Fig 2-C, magnets **22** have been brought into contact with surface **10**. Magnets **22** are strong enough that, when they are in contact with (or in very close proximity to) surface **10** they can hold themselves to surface **10** against the bias

force exerted by springs **28**. Magnets **22** may be moved between the configuration of Fig 2-B and the configuration of Fig 2-C by driving them onto surface **10** using a suitable actuator (not shown). When pole pieces **26** are in contact with ferromagnetic surface **10** they form part of a magnetic circuit. A substantial portion of the flux generated by permanent magnet **24** is channeled into this circuit, thus providing a high clamping force. Because magnet assemblies **22** are able to move relative to frame **21**, different thickness media **11** can be clamped while maintaining contact between pole pieces **26** and ferro-magnetic surface **10**. Once a magnet assembly **22** is in contact with ferromagnetic surface **10**, the attractive forces are high.

[0018] While clamp **20** is secured to surface **10** by magnets **22**, springs **28** cause edge **21A** of frame **21** to clamp media **11** to surface **10**. The clamping force applied to the media **11** is provided by pre-loaded springs **28**. Advantageously, since the pole pieces of magnets **22** remain in contact with surface **10**, the anchoring force between magnets **22** and surface **10** is not affected by the thickness of media **11**. In prior art magnetic clamping systems in which media **11** is between a magnet and a surface the force of attraction between the media and the surface can decrease with the thickness of the media being clamped.

[0019] In FIG. 3, clamp **20** is shown with an electromagnetic retracting device **40** installed on each magnet assembly **22**. Retracting devices **40** each have a core **42** of ferromagnetic material in an inverted U-shape. A coil **56** is wound around core **42**. Coil **56** can be wound around one leg of core **42**, as shown. The operation of retracting device **40** to place clamp **20** is explained with reference to FIGS. 4-A to 4-D. In FIG. 4-A, permanent magnet **24** is polarized in the direction of arrow **50** thus establishing a magnetic flux through the core **42** of retracting device **40** in the direction indicated by arrow **52**. A large portion of the magnetic flux is channeled through core **42** providing a strong attachment force to pole pieces **26**.

[0020] In FIG. 4-B, pole pieces **26** are driven into contact with ferromagnetic surface **10** by an actuation force F, shown by arrow **32**, applied to the retracting device. Under these conditions, the magnetic flux divides between retracting device core **42**, in the direction indicated by arrow **52**, and the magnetic circuit formed

through ferromagnetic surface **10** indicated by arrow **54**. The attractive forces between magnet assembly **22** and the retracting device **40** on one hand, and magnet assembly **22** and ferromagnetic surface **10**, on the other hand, are of similar magnitude so that magnet assemblies **22** remain on the retracting device while being brought into contact with ferromagnetic surface **10**. While it is not essential that these forces be exactly the same, they can be balanced to a sufficient extent by choosing the materials and dimensions of the retracting device to channel enough magnetic flux through core **42**.

[0021] Referring now to FIG. 4-C an electrical current is now applied to coil **56** by current source **58**. The electrical current establishes a magnetic flux in a direction indicated by arrow **60**, in opposition to the flux generated by permanent magnet **24**, thus weakening the attractive force between the magnet and retracting device core **42**. At the same time, the magnetic flux **54** is strengthened as the magnetic flux from permanent magnet **24**, in the direction of arrow **50**, is mostly channeled into the magnetic circuit defined by pole pieces **26** and ferromagnetic surface **10**.

[0022] Finally, in FIG. 4-D retracting device **40** is removed from magnet assembly **22** by applying an actuation force F' in the direction shown by arrow **59**. Retraction is easily accomplished under conditions of reduced force as established by the current flow through coil **56**, thus leaving magnet **22** firmly located on the imaging bed **10**.

[0023] Advantageously the clamping scheme described allows clamping with high force, irrespective of media thickness while not subjecting clamp frame **21** to forces that may damage it.

[0024] Clamp **20** may be removed from surface **10** by essentially reversing the above-described process of placing it. FIGS. 5-A to 5-C illustrate a method for removing clamp **20** from surface **10**. In FIG. 5-A core **42** of retracting device **40** is spaced apart from magnet assembly **22** with no current applied to coil **56**. In FIG. 5-B, retracting device **40** is brought into contact with pole pieces **26**. A current is applied by current source **58** to coil **56**, this time in the reverse direction thus establishing a magnetic flux **62** that co-operates with the flux through core **42** due to permanent magnet **24**. This ensures the force of attraction between magnet assembly **22** and retracting device **40** is stronger than the force between magnet

assembly **22** and ferromagnetic surface **10**. Thus magnet assembly **22** can be pulled away from surface **10** by applying force to retracting device **40**.

[0025] The force exerted by springs **28** reduces the force required to pull clamp **20** off of surface **10** and therefore reduces the required flux by some amount thus requiring a lesser coil current for un-clamping than for clamping. The amount of reduction depends on the stiffness of springs **28**. In FIG. 5-C, clamp **20** is shown in a retracted position having been pulled off by an actuator (not shown) applying an actuation force F" in a direction shown by arrow **64**. Magnet assembly **22** and retracting device **40** remain connected while the force is broken between magnet assembly **22** and ferromagnetic surface **10**.

[0026] It should be apparent to a person skilled in the art that many variations in the process may be readily envisaged. In one specific variation of the above clamping and un-clamping schemes a current is applied earlier in FIG. 4-A thus speeding up the placing process. Similarly, as shown in FIG. 6, a current can be applied prior to bringing retracting device core **42** into contact with magnet assembly **22**. Many other variations are possible without departing from the scope of the invention.

[0027] The current source for energizing coils in retracting device **40** may comprise one or more suitable electrical power supplies. Additional circuitry may be provided to switch the current on and off as well as to provide for reversal of current flow. The switching and reversal functions may be provided by relays or semiconductor devices. In as much as such systems are well known in the art the details will not be further discussed herein.

[0028] Clamp **20** may comprise a single bar clamp with a plurality of magnets spanning the width of a drum surface. In the alternative, the bar could be segmented into a number of smaller clamps. A full bar clamp may not be optimal for clamping plates of different widths, since when clamping a narrow plate only part of the clamp will be over the plate surface. Segmenting the clamp allows each clamp to locally adapt to the plate underneath and also reduces risk of damage should a single clamp fly-off as opposed to an entire bar flying off.

[0029] In another alternative embodiment, the electromagnetic retracting device **40** described above is replaced by a permanent magnet retracting device. In such a device, a permanent magnet provides the opposing magnetic flux. In such a device, it is necessary to provide a means for changing the magnetic flux direction. This may be accomplished by either providing a pair of permanent magnets on an actuator disposed to have opposite polarizations or by rotating a single magnet.

[0030] In another embodiment, the clamp shown in FIG. 3 is constructed without the slidable magnet assembly **22** and springs **28** i.e. with magnet assembly **22** securely attached to clamp frame **21**. As stated earlier the advantage of using a slidable magnet is that different thickness media may be clamped without compromised force since pole pieces **26** always contact ferromagnetic surface **10**. However, if the thickness of media is substantially the same for all media to be loaded, a non-slidable magnet may be disposed to always contact the imaging bed surface and hence provide the benefits of the invention. In this embodiment, the retracting device still functions in essentially the same manner, opposing or reinforcing the flux of the permanent magnet in clamping and un-clamping operations.

[0031] In another embodiment, the retracting device **40** shown in FIG. 3 is replaced by a shorting bar **70** as shown in FIG. 6. A ferro-magnetic material **72** such as steel provides a magnetic circuit for flux to flow in the direction of arrow **74**. The diversion of flux to this circuit weakens the force between surface **10** and magnet **22**. By making shorting bar **70** from areas of ferromagnetic material **72** and non-ferromagnetic material **76** and making the bar slidable in the direction of arrow **78** the shorting may be activated and deactivated by actuation in the direction of arrow **78**.

[0032] In another embodiment shown in FIG. 7 a clamp **80** comprises a frame **82** fabricated from a suitable material, such as sheet metal. Frame **82** locates a pair of magnets **22**, each magnet having a permanent magnetic material **24** flanked by a pair of pole pieces **84**. Pole pieces **26** are elongated to form a pivot at **90** and to retain the magnet assembly **22** on frame **82**. Frame **82** has cut out sections **92** that also serve to form a compliant web-hinge section **88**. The combination of web hinge **88** and protruding tab **86** serve as a spring for biasing magnet **22** away from the underside of clamp **80**. In this embodiment, the magnet does not slide in the frame

82 but rather moves relative to an underlying surface via web-hinges **88**. The operation of clamp **80** is otherwise similar to that shown in FIG's. 5-A to 5-D and FIG. 6 except that magnet **22** is pivoted and transcribes an arc in moving from a position biased away from the imaging bed to a position in contact with the imaging bed.

[0033] The pull-off force necessary to remove the magnets from surface **10** may be reduced by applying a force preferentially to one end of the magnet so that the magnet is pivoted out of attachment with the surface thus weakening the attractive forces along the edge. This reduces the pull-off force required. In an alternative embodiment, shown in FIG. 8-A and in enlarged detail in FIG. 8-B, a clamp **100** has a lever **102** for lifting the edge of magnet **22**. Lever **102** has a pivot **104** and the application of a force to pad **106** on lever **102** results in a force being preferentially applied to a point **108** on one side of magnet **22**. The actuation to lever **102** at pad **106** may be provided by an actuation bar (not shown).

[0034] Various other embodiments of the invention which combine:

- a magnet assembly **22** which can be magnetically affixed to surface **10**,
- a media hold down member (such as edge **21A**) which is biased toward surface **10** when the magnet assembly is affixed to surface **10** and can thereby accommodate media **11** of different thicknesses

are provided by this invention. In some embodiments the magnet assembly and media hold down member are connected so that, with the media hold down member in contact with media **11** or surface **10**, the magnet assembly can be supported in a retracted position wherein it is not fully magnetically engaged with surface **10** and then selectively displaced into an engaged position wherein the magnet assembly is more strongly magnetically engaged with surface **10**.

[0035] Figs 9A and 9B illustrate the principle of operation of a clamp **200** according to one such alternative embodiment of the invention. Clamp **200** has a magnet assembly **22** comprising magnet **24** and poles **26** which is pivotally attached to a hold down bar **221**. An edge of hold down bar **221** bears against media **11**. A spring **228** biases magnet assembly **22** toward the tilted "retracted" position shown in FIG. 9A.

[0036] Figs. 10A and 10B illustrate the principle of operation of a clamp **300** according to a further embodiment of the invention. In clamp **300**, media hold down bars **311** are biased away from frame **301** (i.e. toward surface **10** by springs **303** which are bent around pins **305, 307** and **309**. The edges of media hold down bars **311** constitute media engaging portions. In this embodiment, magnet assembly **22** comprising pole pieces **26** and permanent magnet **24** do not move relative to frame **301** in use. In Fig 10A, magnet assembly **22** and frame **301** are in a retracted position. In Fig. 10B, magnet assembly **22** and frame **301** are in an extended position.

EXAMPLE 1

[0037] A clamp and retracting device similar to that shown in FIG. 4 was constructed. A pair of Neodymium Iron Boron magnets having an energy product of approximately 50 MGOe were supplied by Magnetic Component Engineering, Inc. of Torrence, CA. The pole pieces were made of mild steel and at contact with the ferromagnetic surface; the attractive force provided was approximately 330 Newtons per magnet. The springs were chosen to have a force of approximately 200 Newtons per magnet leaving a holding force of approximately 130 Newtons per magnet. The clamps were used to secure a 0.02 inch thick aluminum plate to a drum of diameter approximately 17 inches (432 mm). Under these conditions, the drum was run up to angular speeds in excess of 520 rpm without clamp fly-off or slippage of the plate under the clamp.

[0038] The retracting device coils were each wound with approximately 1250 turns. The current for clamping was approximately 0.4 Amperes while that for unlocking was approximately 0.2 Amperes, in the opposite direction. Pairs of retracting devices were connected in series and 10 such clamp/retracting devices were constructed and connected in parallel. The supply used was a 24 Volt 3 Amp conventional power supply and relays were used to interrupt and change direction of the current. The clamp was tested to 2.8 million clamping and un-clamping cycles without any significant deterioration.

EXAMPLE 2

[0039] A clamping system for an imaging system was constructed. The system comprised 6 clamps of general dimension 190 mm x 44 mm by 10 mm. Each clamp

had 2 magnets slidably located in a clamp frame and retained by a leaf spring suspension. The force between each magnet and the drum was 240 N providing a total attachment force of 480 N. Under these conditions the clamp flyoff limit was established at a drum rotational speed of 1100 rpm.

[0040] The springs were arranged to apply a force of 116 N for a total spring force of 232 N applied to the media to clamp it to the drum. The media flyoff limit was found to be 730 rpm under these conditions.

[0041] In the various depicted embodiments, permanent magnets **24** have been represented in the illustrations as rectangular-shaped members for sake of convenience. As will be clear to a person skilled in the art, permanent magnets **24** may have any of a wide variety of different shapes without departing from the scope of the invention. Magnets are commonly available in annular ring or cylindrical disk form with a variety of polling directions and a variety of pole piece configurations. The pole pieces of magnet assemblies **22** may be shaped to match a configuration of surface **10**. For example, as shown in FIG. 11, where surface **10** is a surface **110** of a drum having a radius of curvature, the pole pieces **26** of magnet assemblies **22** may be curved to match the radius of curvature of the drum. In Fig 11 the curvature of surface **110** is greatly exaggerated for purposed of illustration.

[0042] As will be apparent to those skilled in the art in the light of the foregoing disclosure, many alterations and modifications are possible in the practice of this invention without departing from the spirit or scope thereof. For example,

- The bias mechanism may comprise springs of configurations other than shown above. Embodiments of the invention may include torsion springs, leaf springs, coil springs, extension springs, compression springs, elastic members, or the like coupled in any suitable manner between the media-engaging portion of a clamp and one or more magnet assemblies to bias the media-engaging portion of a clamp toward a surface of an imaging bed. Any such bias mechanism and any reasonable equivalents thereof may be termed a bias means.

Accordingly, the scope of the invention is to be construed in accordance with the substance defined by the following claims.